MPEG-2 transport, applications and challenges for MMT

- MPEG-2 Transport overview
- Use in applications
  - **Broadcast**
  - **DVD**
  - **IPTV**
- Issues with MPEG-2 TS
- Some requirements for MMT
- Summary

MOTOROLA intelligence everywhere

Overview of MPEG-2 systems

- Provides 2 capabilities - Program and Transport streams.
- Both provide all the information within stream (media data, timing, system information and navigation) for various applications.
- Program streams are commonly used with error free physical media or networks and by applications that use ‘pull’ mode where data is retrieved at a rate determined by application. Examples include DVD and some disk based PVR (even though most of the PVR applications use partial transport stream).
- Transport streams are typically used in broadcast applications that use the ‘push’ mode where data must be processed at the transmission rate by receivers. Networks that use these are both high QoS (such as cable and satellite) as well as lower QoS (such as wireless and cellular).
- Transport is fixed length (188-bytes) with a 4-byte transport header, followed occasionally by a variable length adaptation header and PES header. These headers signal media, random access, timing, synchronization and other information that assist applications such as broadcast, splicing and scrambling. Rest of the data bytes in transport are for codec’s and other information.
- Adaptation header includes clock (PCR) and other information to assist in random access, discontinuity processing and splicing streams from independent sources.
- PES header includes time stamps (PTS/DTS) for a/v/data synchronization as well as other information to assist scrambling, right indication and trick modes.
- In addition to PES, MPEG transport provides ‘section’ structure with CRC to assist in transmission of priority information such as program specific information.

MPEG-2 transport packet structure

Each packet is 188-byte packets

MPEG-2 TRANSPORT STREAM

Transport Packet	Transport Packet	Transport Packet	Transport Packet

MPEG-2 TRANSPORT PACKET

Transport Packet Header	Transport Packet Adaptation Field	Transport Packet Payload

MPEG-2 TRANSPORT PACKET HEADER

Sync Byte	Packet Error Indicator	Unit Start Indicator	Transport Priority	PID	Scrambling Control	Adaptation Field Control	Continuity Counter

MPEG-2 TRANSPORT PACKET ADAPTATION

Adaptation Field Length	Adaptation Field Flags	Adaptation Field Data

TRANSPORT PACKET ADAPTATION HEADER

Adaptation Field Length	Discontinuity Indicator	Random Access Indicator	Elementary Stream Priority Indicator	PCR Flag	OPCR Flag	Splicing Point Flag	....

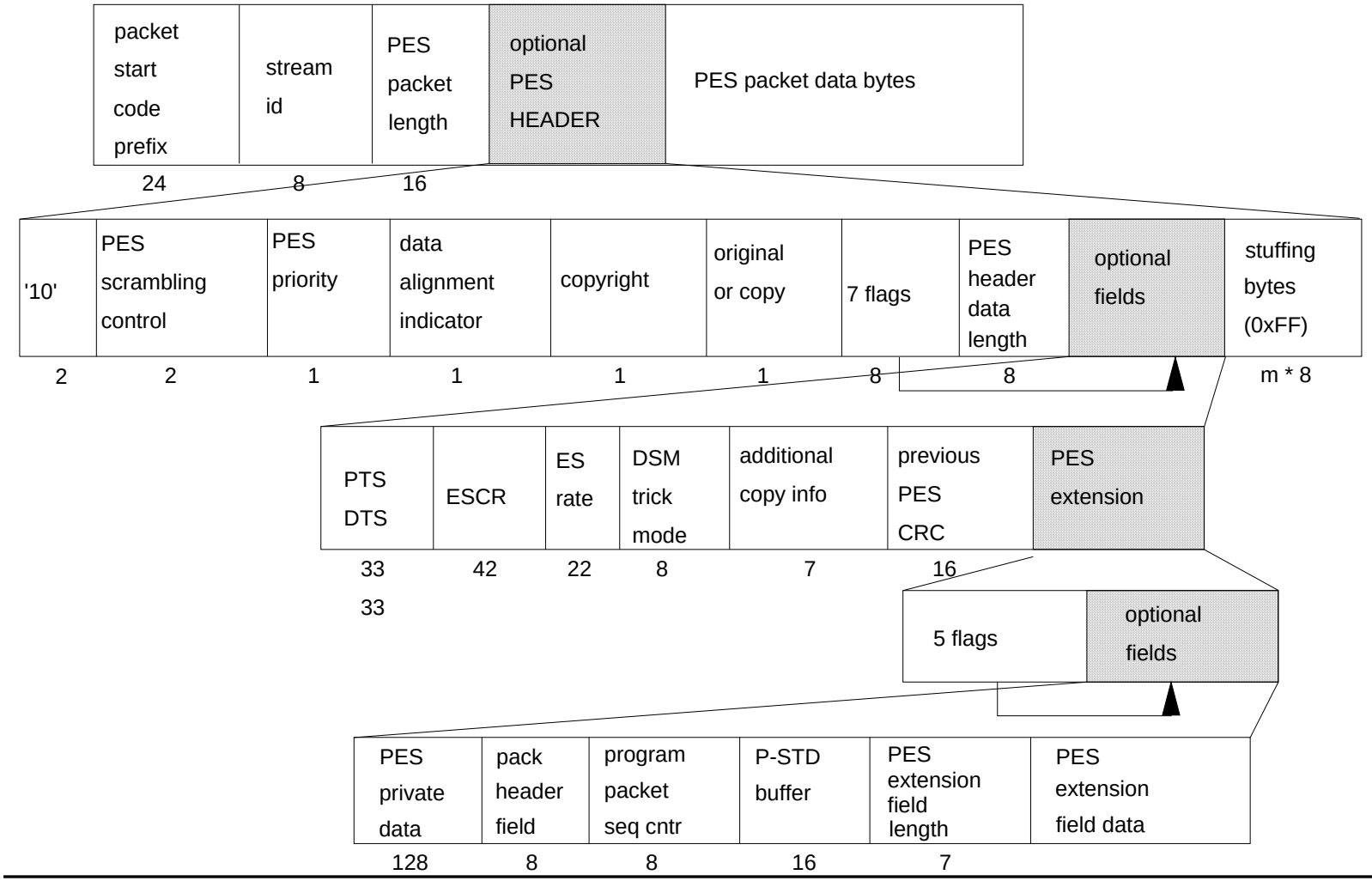
...	Transport Private Data Flag	Adaptation Field Extension Flag

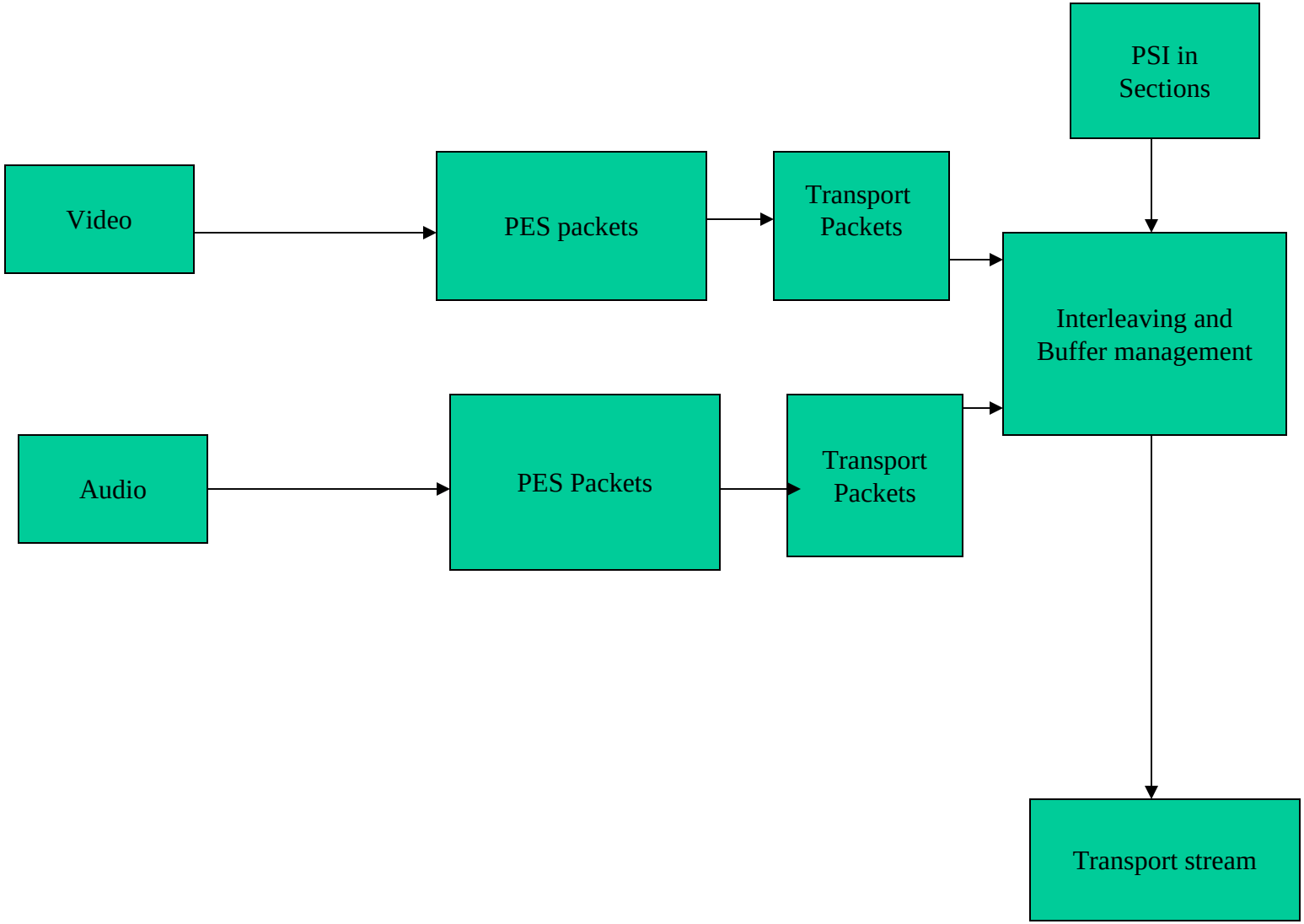
- If any flag is set to ‘1’ (is active), then the relevant field is present in the adaptation header Data.

MPEG-2 TRANSPORT PACKET ADAPTATION FIELD DATA

PCR Data Field	OPCR Data Field	Splice Countdown	Adaptation Private Data Field	Adaptation Extension Field	Stuffing

PES header information

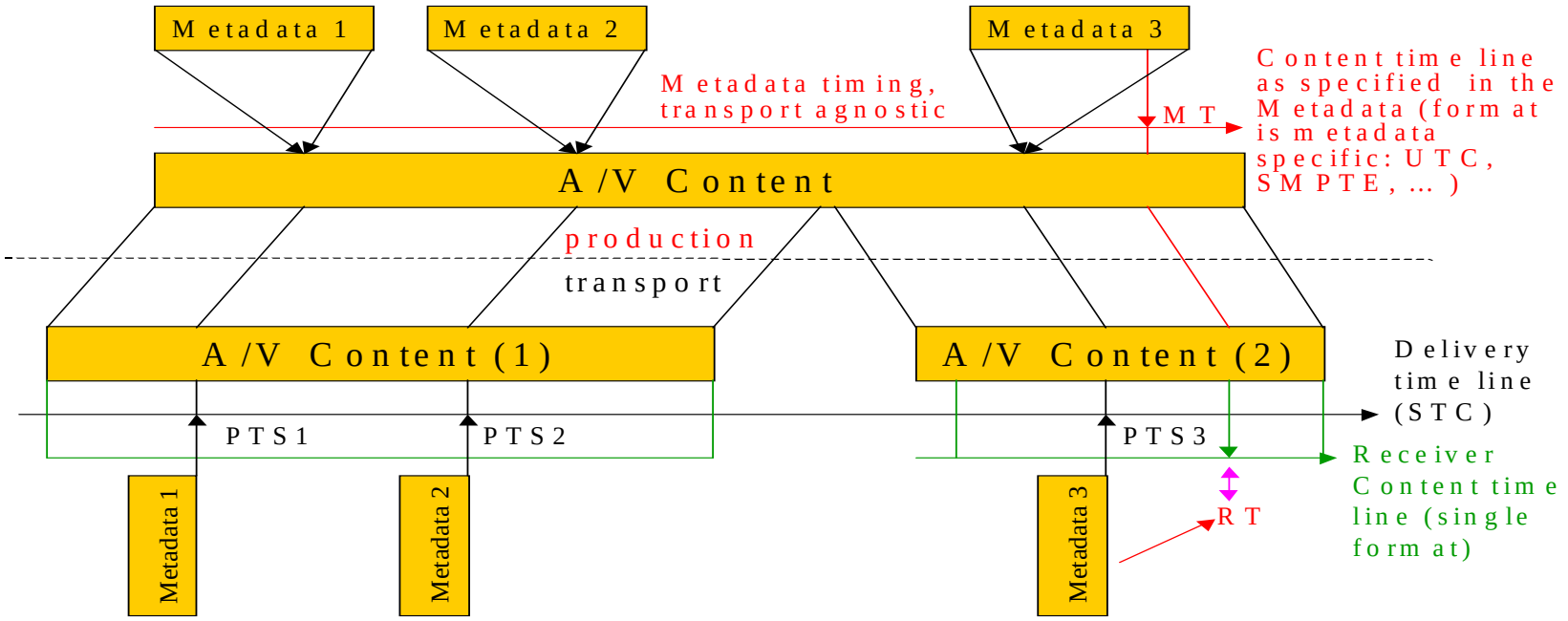




PID and Program specific information (PSI)

- Each PID value contains data for a particular component such as audio or video or other data. A transport stream can contain a single program (SPTS) or can be a multiplex of many programs (MPTS).
- Few ‘specific’ PID values in transport packets are allocated to signal multiplex information.
- PID value ‘0’
  - Called program association table (PAT)
  - Includes list of pointers referencing program numbers and PID values (called PMT-PID) that define additional information
- PID value ‘1’
  - Called conditional access table (CAT)
  - Includes list of PID values that carry conditional access information
  - Used by applications for transmission of entitlement management information. MPEG does not standardize the information part.
- PMT PID
  - Specified via PAT and can be any value other than ‘specific’ PID values (0,1,2,3 and 0x1FFF).
  - Includes list of components in a ‘program’ or channel such as video, audio, data, meta data etc and PID values for each component.
  - Also includes pointer to PID carrying information to assist in descrambling components that are encrypted (sometimes called ECM PID).
  - Includes additional information for each component (descriptor) that may help applications.

Example of metadata transport



Broadcast application example

- **Broadcast has been the most compelling application for MPEG codec's.**
- **Broadcast usually requires the following functions:**
  - Random access for channel change.
  - Quick channel change preferred.
  - Splicing for ad-insertion.
  - Carriage of regulatory information.
  - Modulation/FEC customized for transport.
  - Conditional access.
  - DRM support.
  - PVR assistance (trick mode support).
  - Program guide/EPG via system information.
  - Support re-transmission and re-distribution.

Broadcast standards

- **US standards include ATSC (for terrestrial broadcast that uses 8-VSB) and SCTE (for cable and satellite delivery using QAM and QPSK).**
- **DVB/ETSI standards support networks that use both MPEG-2 TS and IP protocols. Networks include satellite, cable, terrestrial broadcast as well as hybrid networks.**
- **ARIB standards specify use of MPEG-2 TS in various networks including terrestrial and satellite.**
- **All these standards specify some the following functions based on MPEG-2 TS in addition to a/v/data synchronization:**
  - Fast channel acquisition using random access.
  - Carriage of closed captioning, teletext, subtitles and AFD/Bar Data.
  - System Information (sometimes called SI) in addition to MPEG PSI to support navigation, EPG (using Event Information Table) and PVR recording.
  - Common interfaces for Conditional Access.
  - Partial transport streams and their use in 1394 and some disk based PVR.
  - Digital ad-insertion using transport level and stream level splicing using cue timing (ITU-T J.181).
- **Data broadcast standards in DVB and ATSC are based on the DSM-CC specification of MPEG. This is not as popular as broadcast application standards.**

Other applications – DVD and IPTV

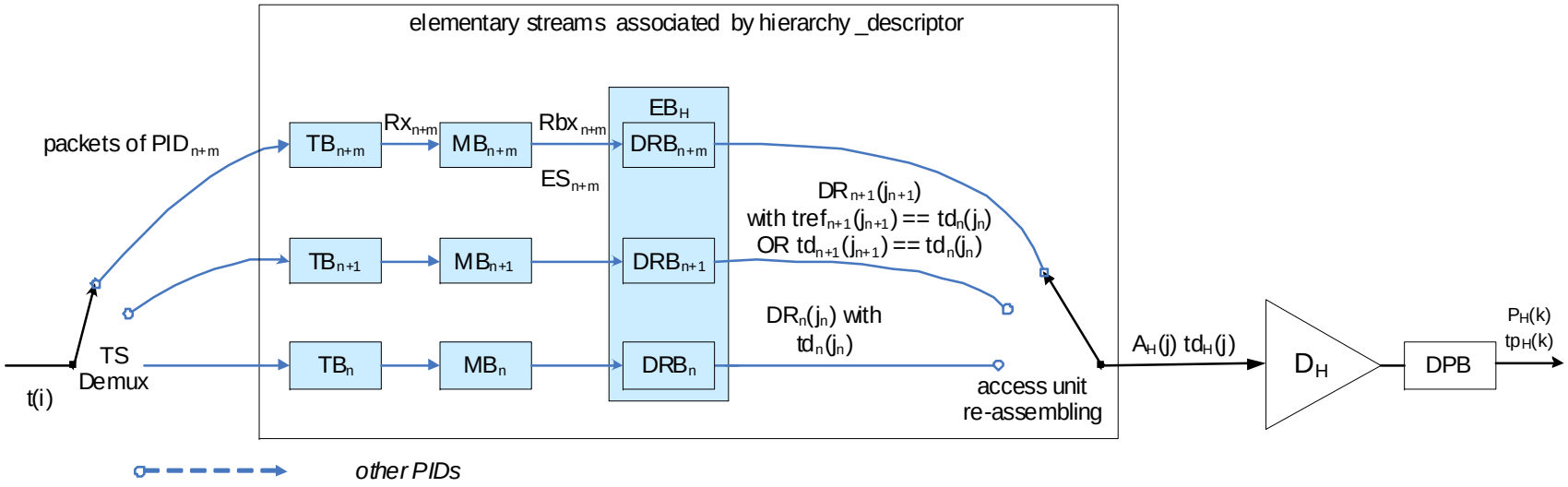
- **DVD has been another compelling application that uses the program stream.**
- **Functions supported include subtitles, segmentation and smooth trick play modes (such as pause, fast forward, fast reverse, slow motion).**
- **A/V synchronization with multiple audio formats.**
- **DVD uses fixed length PES packets while broadcast uses zero length packets for video.**
- **IPTV applications for DTV are getting popular now.**
- **Majority of HDTV delivery over IP networks use MPEG-2 TS as underlying layer below IP/UDP/RTP so that many of the architectures developed for MPEG-2 TS can be re-used.**
- **Cable modem applications use MPEG-2 TS for carriage of IP datagram's. This is done to maintain the same modulation/FEC tools used for DTV delivery.**

Issues with MPEG-2 transport

- **Major issue is the popularity and continued use of MPEG-2 systems making it heavily overloaded with code points for all codec's being developed by MPEG and other standards bodies.**
- **Since 1994, MPEG-2 systems has added numerous corrigendum and amendments (over 20) resulting in 2 new editions (2000 and 2007).**
- **There are very few values left for signaling elements stream_type, stream_id and descriptors resulting in complex extension mechanisms (such as stream_id_extension).**
- **Many flags and bits that were deemed useful in 1994 (in adaptation and PES) have not found much use – these cannot be deleted for legacy support.**
- **Use of same signaling mechanisms for random access, data alignment, splicing and other functions for many codec's is making the standard complex for future implementations.**
- **STD model forces new codec's to factor it into design and may reduce the future capabilities.**
- **STD extensions for scalable codec's are getting complex (SVC and MVC) for encoding and decoding systems.**

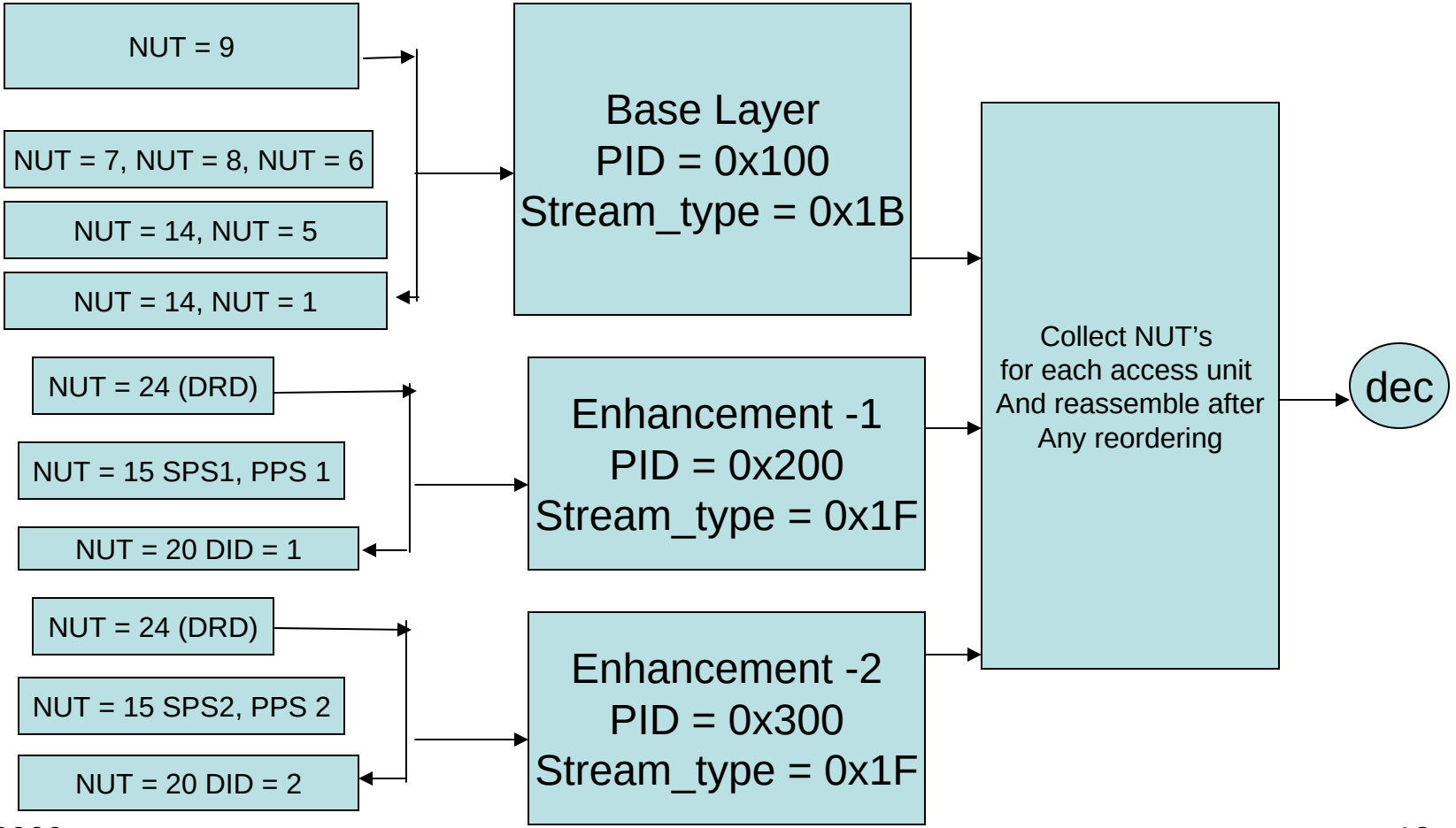
STD extensions - AMD3 to MPEG-2 systems (SVC transport)

SVC and MVC STD example



Example : SVC access Unit re-assembly

Example of re-assembly based on base layer and 2 enhancement layers:



Some requirements for MMT (based on current use cases of MPEG-2 TS and future needs)

- **Provide unique signaling for each codec.**
- **Support synchronization between multiple components.**
- **Support synchronization between components in a hybrid network.**
- **Support re-multiplexing and consolidation of several MMT.**
- **Support splicing of streams at MMT level.**
- **Enable user private capability.**
- **Support many applications including application requirements for broadcast, multicast, storage media, home network and mobile.**
- **Support both push, pull, unicast and multi-user capability.**
- **Provide tools for error detection/correction in addition to hooks to generate FEC for legacy networks.**
- **Decoder implementations should not be very complex.**
- **If MPEG-2 TS can be a subset of MMT, it would be great.**

Summary

- **MPEG-2 TS has been very popular for many applications.**
- **MPEG-2 PS has been widely used in SD-DVD and newer HD capable Blu-ray systems.**
- **With the development of newer codec's, MPEG-2 TS is getting overloaded and we need to migrate to a new transport.**
- **However, we still need many of the functions of MPEG-2 TS supported by a new transport.**
- **It would be good to have a common transport scheme for all networks – this may be hard to achieve.**